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# Extirpation and reintroduction of fishers (*Martes pennanti*) in Oregon: implications for their conservation in the Pacific states

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**Abstract**

Prior to extensive European settlement, the fisher (*Martes pennanti*) occupied most coniferous forest habitats in Washington, Oregon, and California. Human activities since that time have resulted in the apparent extirpation of fishers throughout much of their historical range in the Pacific states. Fisher extirpations in California and Washington have been documented previously, but no comprehensive assessments of the distribution of fishers in Oregon, the history of their translocation into Oregon, or the conservation of fishers in the Pacific states have been conducted. Our objectives are to (1) review historical information on potential causes for fisher population losses in Oregon, (2) document the history of their translocation into Oregon, (3) describe the distribution of fishers in Oregon relative to those translocations and determine if any were successful, and (4) discuss the implications of our findings for the conservation of fishers in the Pacific states. Our results show that extant populations of fishers in Oregon are restricted to two disjunct and genetically isolated populations in the southwestern portion of the state: one in the southern Cascade Range and one in the northern Siskiyou Mountains. In addition, historical changes in the distribution of fisher occurrence records in Oregon and geographic variation in the genetic composition and size of fishers occurring in southwestern Oregon, show that the population in the southern Cascade Range is reintroduced and is descended from fishers that were translocated to Oregon from British Columbia and Minnesota. The loss of fisher populations from central and northern Oregon and throughout Washington has resulted in the isolation of extant populations in Oregon by >650 km from those occurring in southern British Columbia. Our results demonstrate that the historical continuity in fisher distribution that once provided for genetic interchange among fisher populations in the Pacific states no longer exists.
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The fisher (*Martes pennanti*) is one of the most habitat-specialized mammals in western North America (Buskirk and Powell, 1994). Its occurrence is closely associated with low- to mid-elevation (generally <1250 m) forests with a coniferous component, large snags or decadent live trees and logs for denning and resting, and complex physical structure near the forest floor to support adequate prey populations (Buskirk and Powell, 1994; Powell and Zielinski, 1994). Prior to extensive European settlement, fishers occupied most coniferous forest habitats in Washington, Oregon, and California (i.e. the Pacific states; Bailey, 1936; Grinnell et al., 1937; Dalquest, 1948). Since that time, human activities that either caused direct mortality of fishers or the loss or degradation of suitable habitat, have resulted in the apparent extirpation of fishers throughout much of their historical range in the Pacific states (Marshall, 1992; Zielinski et al., 1995; Lewis and Stinson, 1998). Observed contractions in the geographic distribution of fishers in the Pacific states and a perceived need to conserve their primary habitats have resulted in three petitions to list fisher populations in the Pacific states as federally endangered or threatened (Beckwitt, 1990; Carlton, 1994; Greenwald et al., 2000). The first two petitions were rejected (US Fish and Wildlife Service, 1991, 1996); as of this writing, a 90-day finding for the third petition is pending.

In many areas of the USA where indigenous fisher populations have been extirpated, reintroduction has

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been an effective conservation measure (Berg, 1982). Reintroductions of fishers have occurred in several western states, including Montana in 1959–1960 and 1988–1991 and Idaho in 1962–1963 (Williams, 1962, 1963; Weckworth and Wright, 1968; Roy, 1991; Heinemeyer, 1993). Among the Pacific states, only Oregon has attempted to reintroduce fishers (Kebbe, 1961). Published information on the Oregon reintroductions is either limited in scope or lacking. Kebbe (1961) reported that 24 fishers were translocated from the region north of Kamloops, British Columbia to Oregon in early 1961; 11 (6 females [F], 5 males [M]) were released near Klamath Falls in the southeastern Cascade Range, and 13 (8 F, 5 M) were released near La Grande in the Wallowa Mountains. A third translocation site in the southwestern Cascade Range was depicted by Strickland et al. (1982), but no additional information was provided. This record may represent translocations that reportedly occurred in 1981; according to J. Schneeweis (personal communication cited in Berg, 1982), 13 fishers (5 F, 8 M) were translocated from Minnesota to Oregon in the fall of 1981. No other published information is available on the translocation of fishers to Oregon.

The distribution and conservation status of extant populations of fishers in California and Washington (i.e. since 1989 and 1990, respectively) were described previously (Zielinski et al., 1995; Lewis and Stinson, 1998), but no comprehensive assessments of the distribution of fishers in Oregon, the history of their translocation into Oregon from other regions, or the conservation of fishers in the Pacific states have been conducted. Our objectives are to (1) review historical information on potential causes for the extirpation of fisher populations in Oregon, (2) document the dates, release sites, and source populations of fisher translocations into Oregon, (3) describe the distribution of fishers in Oregon relative to those reintroduction efforts and determine if any were successful, and (4) evaluate the implications of our findings for the conservation of fishers in the Pacific states.

## 1. Methods

### 1.1. Review of historical information

To evaluate potential causes for the extirpation of fisher populations in Oregon, we examined published literature, unpublished reports and documents at museums and state and federal resource management agencies, and the field notes of trappers and early naturalists. Because of strong commonalities in the vegetative composition and physiography of forested habitats in Washington and Oregon, habitat conditions for fishers are similar in both states (Franklin and Dyrness, 1973). Consequently, we also considered historical information on fishers in Washington when relevant historical accounts from Oregon were lacking. To document the history of fisher reintroduction efforts in Oregon, we examined Oregon Department of Fish and Wildlife (ODFW) files relating to fisher translocations. In addition, we contacted current and retired personnel at ODFW, USDA Forest Service (USFS), USDI Bureau of Land Management (BLM), and private timber companies that participated in fisher reintroductions to obtain detailed information on the geographic locations and dates of translocations, and the geographic origin, number, sex, and age of translocated fishers.

### 1.2. Distribution of extant fisher populations in Oregon

To document the distribution of fishers in Oregon, we sent questionnaires to 1781 registered trappers and hound hunters in Oregon in 1995, requesting first-hand accounts of incidental captures or visual observations of fishers or their tracks. To the extent possible, we conducted phone interviews with individuals that responded to our survey to obtain additional information and assess the qualifications of each observer. We also examined the files of museums and state and federal resource management agencies for records of fishers in Oregon.

During the last decade, many resource management agencies in the Pacific states have conducted standardized surveys using remotely operated cameras and sooted track-plate boxes to determine the presence or absence of fishers and other rare forest carnivores within their administrative area (Zielinski and Kucera, 1995; Aubry et al., 1997). Most surveys for fishers have been based on sampling techniques recommended by Zielinski and Kucera (1995) involving the deployment of either two remote 35-mm or video cameras, or six track-plate boxes or line-triggered cameras within a 4 mile$^2$ (10.4 km$^2$) sample unit for 12–28 days, depending on the detection device used. The sample unit is a square area 2 miles (3.2 km) long on each side, whose geographic location is determined by the township/range/section (TRS) system derived from Public Land Surveys. Thus, a 36-mile$^2$ (93.2-km$^2$) township contains 9 potential sample units, each consisting of four 1-mile$^2$ (2.6 km$^2$) sections arranged in a square. The geographic extent and results of standardized surveys for forest carnivores have been summarized for Washington (Lewis and Stinson, 1998) and California (Zielinski et al., 1995), but no similar assessment has been conducted for Oregon. To obtain detailed information on the geographic locations and results of remote-camera and sooted-track plate surveys conducted in Oregon since 1990, we examined information available from ODFW, USFS, and BLM in 1996 and 2000. We compiled all fisher occurrence records and standardized survey data into a spatially referenced database.

We assigned a numerical reliability rating (sensu Aubry and Houston, 1992) to each fisher occurrence record as follows: 1. Specimens, photographs, video footage, or sooted track-plate impressions (records of high reliability that are associated with physical evidence); 2. Reports from trappers or hunters of fishers being trapped or treed by dogs and released (records of high reliability that are not associated with physical evidence); 3. Visual observations from experienced observers or from individuals who provided detailed descriptions that supported their identification (records of moderate reliability); 4. Observations of tracks by experienced individuals (records of moderate reliability); 5. Visual observations of fishers by individuals of unknown qualifications or that lacked detailed descriptions (records of low reliability); 6. Observations of any kind with inadequate or questionable description or locality data (unreliable records).

We eliminated all low-reliability and unreliable occurrence records (ratings of 5 and 6) from further consideration, and used several subsets of the remaining data in our analyses. To compare recent changes in the distribution of fishers in Oregon with the dates and locations of fisher translocations, and to describe the current distribution of fishers in Oregon, we followed procedures used by McKelvey et al. (2000) and included only records of high reliability (ratings of 1 and 2; hereafter referred to as 'verified' records) dating from 1961 to 2001 that we could plot as a point location on a map to within 1 mile$^2$ (2.6 km$^2$). We evaluated the geographic distribution of high- and moderate-reliability fisher occurrence records (ratings of 1–4; hereafter referred to as 'unscreened' records), standardized surveys with remote cameras or sooted track-plate boxes, and resulting photo or track-plate detections of fishers in the Pacific states by plotting each township (93.2 km$^2$) in which one or more occurrence record, survey effort, or detection was made. For comparability with previously published occurrence records from Washington (1955–1992; Aubry and Houston, 1992) and California (1960–1987; Schempf and White, 1977; Gould, 1987), we used only occurrence records from Oregon dating from 1954 to 1992. Standardized surveys using remote cameras or track-plate boxes were conducted from 1990 to 1997 in Washington (Lewis and Stinson, 1998), from 1990 to 2000 in Oregon (this study), and from 1989 to 1994 in California (Zielinski et al., 1995).

## 2. Results

### 2.1. Potential causes of fisher extirpations in Oregon

#### 2.1.1. Direct mortality from trapping and predator control efforts

Overtrapping appears to have been the primary initial cause of fisher population losses in this region (Dixon, 1925; Grinnell et al., 1937; Marshall, 1992; Scheffer, 1995). During the early 1900s, fishers were among the most valuable of all terrestrial furbearers (Novak et al., 1987; Lewis and Zielinski, 1996); in the early 1920s, prime skins were reportedly worth up to $150 each (Bailey, 1936). In addition, fishers are easily trapped (Powell, 1993), and the low- to mid-elevation coniferous forests where fishers were most abundant were accessible to trappers during all seasons of the year. These factors, combined with a lack of trapping regulations, resulted in heavy trapping pressure on fishers in the late 1800s and early 1900s. The Oregon State Legislature began managing furbearer populations in 1913 by prohibiting the trapping of five species, including fishers, during the non-winter months and requiring that each trapper provide a report of catch after each trapping season (Anonymous, 1914a; Jewett, 1915). Two years later, Jewett (1915) warned that fishers were "rapidly disappearing [from Oregon], and, unless protection is afforded [them], soon will disappear forever from our forests". According to state trapping records from 1924 to 1936, only 2–13 (mean = 8) fishers were trapped each year in Oregon despite widespread commercial trapping pressure (Kebbe, 1961). These records may reflect a decline in fisher harvests statewide by the late 1920s and early 1930s, because it was reportedly common for individual trappers to catch 6–8 fishers in a single trap line in the Cascade Range in Oregon prior to 1920 (B. Clark, personal communication cited in Marshall, 1992; see also Anonymous, 1914b).

Historical accounts of the harvest of fishers in Oregon during the early 1900s are scarce, but records from coastal forests in Washington provide insights into the potential effects of trapping mortality on fisher populations occupying similar habitats in Oregon. Prior to 1933, trapping of fishers was unregulated in the state of Washington. Two trappers reportedly killed 37 fishers in the winter of 1920 along the Queets River from the town of Clearwater to the coast, which sold for $75 each (Scheffer, 1995). Scheffer (1995) also reported that two brothers had killed 20 fishers along the East Fork of the Quinault River during the winter of 1921 at elevations ranging from 500 to 1500 m. The Queets and Quinault Rivers occupy adjacent drainages on the Olympic Peninsula in northwestern Washington. Clearwater is $<10$ km east of the coast; the watershed encompassed by this portion of the Queets River drainage is about 50 km$^2$ in extent. The watershed containing the upper elevation areas along the East Fork of the Quinault River described by Scheffer is about 200 km$^2$ in area. Thus, these trapping records indicate a human-caused mortality rate on the lower Queets River in 1920 of 74 fishers per 100 km$^2$ and, on the upper Quinault River during the following year, of 10 fishers per 100 km$^2$.

Incidental poisoning from predator control efforts has been implicated in the decline of fisher populations in

other regions of North America (Douglas and Strickland, 1987) and may also have played a role in population losses in the Pacific states. Predator control efforts involving extensive poisoning and trapping campaigns were conducted throughout Oregon and Washington in the early 1900s (Bailey, 1930a,b; McIntyre, 1995). In the Pacific Northwest, the historical ranges of the northwestern timber wolf (*Canis lupus fuscus*) and the fisher overlapped extensively, and it is likely that trapping and the use of strychnine baits to eliminate wolves and control coyotes may have contributed to local extirpations of fishers (Marshall, 1992). By the 1930s, however, timber wolves had been extirpated from much of their original range in the Pacific states (Bailey, 1936; Grinnell et al., 1937; Dalquest, 1948), and most predator control efforts in forested habitats had ended.

#### 2.1.2. Habitat loss from timber harvest and human development

In the Pacific states, fishers were most abundant historically in low- to mid-elevation, conifer-dominated forests having relatively continuous canopies and complex physical structure near the forest floor (Aubry and Houston, 1992; Powell and Zielinski, 1994; Scheffer, 1995). In the western USA, fishers generally avoid clearcuts and forested stands with $<40\%$ canopy cover (Buck et al., 1994; Jones and Garton, 1994), and occur at low densities in second-growth forests (Powell and Zielinski, 1994) and landscapes that have been extensively fragmented by timber harvesting (Rosenberg and Raphael, 1986; Carroll et al., 1999). Fishers probably avoid high-elevation forests in that region because of their inability to hunt or travel efficiently in the soft, thick snowpacks that often form in subalpine forests (Raine, 1983; Aubry and Houston, 1992; Krohn et al., 1995). Late-successional forest structures are also key habitat components. Female fishers give birth and raise kits in cavities in large-diameter ($>80$ cm dbh) live trees, snags, and logs, and use these structures and large platform branches for rest sites (Powell and Zielinski, 1994; Truex et al., 1998; Aubry and Raley, 2002).

In the early 1900s, the most commercially valuable and accessible timber was in private ownership at low elevations near major rivers and estuaries; such sites were also the most desirable locations for human settlement (Harris, 1984). In the Pacific Northwest, low- and mid-elevation old-growth Douglas-fir (*Pseudotsuga menziesii*) forests west of the Cascade crest have been the most heavily altered by clearcut logging and human development (Morrison, 1988; Bolsinger and Waddell, 1993). The concomitant loss and fragmentation of a large proportion of the fisher's primary habitat and decades of overtrapping probably prevented fisher populations in the Pacific Northwest from recovering after the species was protected from trapping and poisoning (Aubry and Houston, 1992; Powell and Zielinski, 1994; Lewis and Stinson, 1998). Ongoing mortality from incidental captures in traps set for other medium-sized furbearers may also be a contributing factor (Lewis and Zielinski, 1996).

Supporting evidence for the extensive loss or degradation of suitable fisher habitat from the clearcutting of old-growth forests at low to mid-elevations in this region is provided by the fate of coastal populations of the American marten (*M. americana*). Martens are closely related to fishers and occupy similar habitats (Buskirk and Powell, 1994; Slauson and Zielinski, 2001); unlike fishers, however, they can hunt efficiently both in the subnivean layer and on the surface of deep snowpacks (Buskirk and Ruggiero, 1994). Martens have remained relatively common in subalpine forests at upper elevations in the Cascade Range, especially where extensive timber harvesting has not occurred (Marshall, 1994). Populations of martens that once co-existed with fishers in low-elevation coastal forests on the Olympic Peninsula and in the Coast Ranges of southern Washington, Oregon, and northern California (Bailey, 1936; Grinnell et al., 1937; Dalquest, 1948), however, have either declined dramatically or been extirpated (Zielinski et al., 2001).

### 2.2. Reintroduction of fishers to Oregon

Three separate attempts were made to reintroduce fishers to Oregon during the last 40 years. The following accounts are summarized from published information, correspondence files provided by ODFW, and interviews we conducted with individuals who participated in the reintroduction efforts. In the 1950s, porcupine (*Erethizon dorsatum*) populations had become unusually dense in southern Oregon, and were causing severe damage to forest plantations (Stone, 1952). Years of control efforts in Klamath County involving poisons, traps, bounty programs, and hunting campaigns had failed to decrease their populations. To supplement these control efforts, the USDA Forest Service and Weyerhaeuser Corporation asked the Oregon State Game Commission to reintroduce fishers to Oregon as a means of restoring a predator of the porcupine. In early 1961, 24 fishers were translocated from south-central British Columbia, Canada to Oregon: 11 to the Cascade Range near Klamath Falls in southwestern Oregon, and 13 to the Wallowa Mountains near La Grande in northeastern Oregon (Kebbe, 1961; Table 1, Fig. 1a). All animals were aged and tagged in one or both ears by Chester E. Kebbe, a biologist with the Oregon State Game Commission; according to his assessment, more than half of the animals released near Klamath Falls were young of the year. The date of the La Grande releases coincided with the average date of parturition for fishers (Powell, 1993); two newborn kits were found dead in one of the crates after the La Grande releases on

Table 1
History of fisher translocations to Oregon

| Date of release | Location of release site | Location of source population | Dates of capture | Number and sex |
|---|---|---|---|---|
| 19 January 1961 | Four locations ~40 km NW of Klamath Falls, OR in the southeastern Cascade Range. E 573752, N 4694269[a]; E 574644, N 4687837[a]; E 572305, N 4682927[a]; E 567524, N 4682879[a] | North of Kamloops, south-central British Columbia, Canada | 27 November 1960 to 15 March 1961 | 11 (6F, 5M) |
| 21 March 1961 | Two locations ~40 km east of La Grande, OR in the Wallowa Mountains. E 447408, N 5027515[b]; E 456872, N 5015000[b] | North of Kamloops, south-central British Columbia, Canada | 27 November 1960 to 15 March 1961 | 13 (8F, 5M) |
| 14 April 1977 | ~30 km west of Crater Lake, OR in the southwestern Cascade Range. E 536870, N 4758051[a] | Near Kamloops and Prince George, south-central British Columbia, Canada | Unknown | 2 (2M) |
| 23 November 1977 | Three locations ~30–45 km southwest of Crater Lake, OR in the southwestern Cascade Range. E 548901, N 4728697[a]; E 548957, N 4720702[a]; E 549014, N 4712596[a] | Near Kamloops, south-central British Columbia, Canada | Fall 1977 | 6 (3F, 3M) |
| 10 January 1978 | ~30 km west of Crater Lake, OR in the southwestern Cascade Range. E 536870, N 4758051[a] | Near Kamloops and Prince George, south-central British Columbia, Canada | Unknown | 3 (2F, 1M) |
| Late February 1978 | ~30 km west of Crater Lake, OR in the southwestern Cascade Range. E 536870, N 4758051[a] | Near Kamloops and Prince George, south-central British Columbia, Canada | Unknown | 3 (1F, 2M) |
| 6 April 1978 | ~30 km west of Crater Lake, OR in the southwestern Cascade Range. E 536870, N 4758051[a] | Near Kamloops and Prince George, south-central British Columbia, Canada | Unknown | 2 (1F, 1M) |
| February 1980 | ~30 km west of Crater Lake, OR in the southwestern Cascade Range. E 536870, N 4758051[a] | Near Kamloops and Prince George, south-central British Columbia, Canada | Unknown | 1 (1M) |
| 14 October 1981 | ~26 km northwest of Crater Lake, OR in the southwestern Cascade Range. E 551345, N 4774136[a] | Near International Falls, northern Minnesota, USA | Unknown | 13 (5F, 8M) |

[a] UTM NAD 27, Zone 10.
[b] UTM NAD 27, Zone 11.

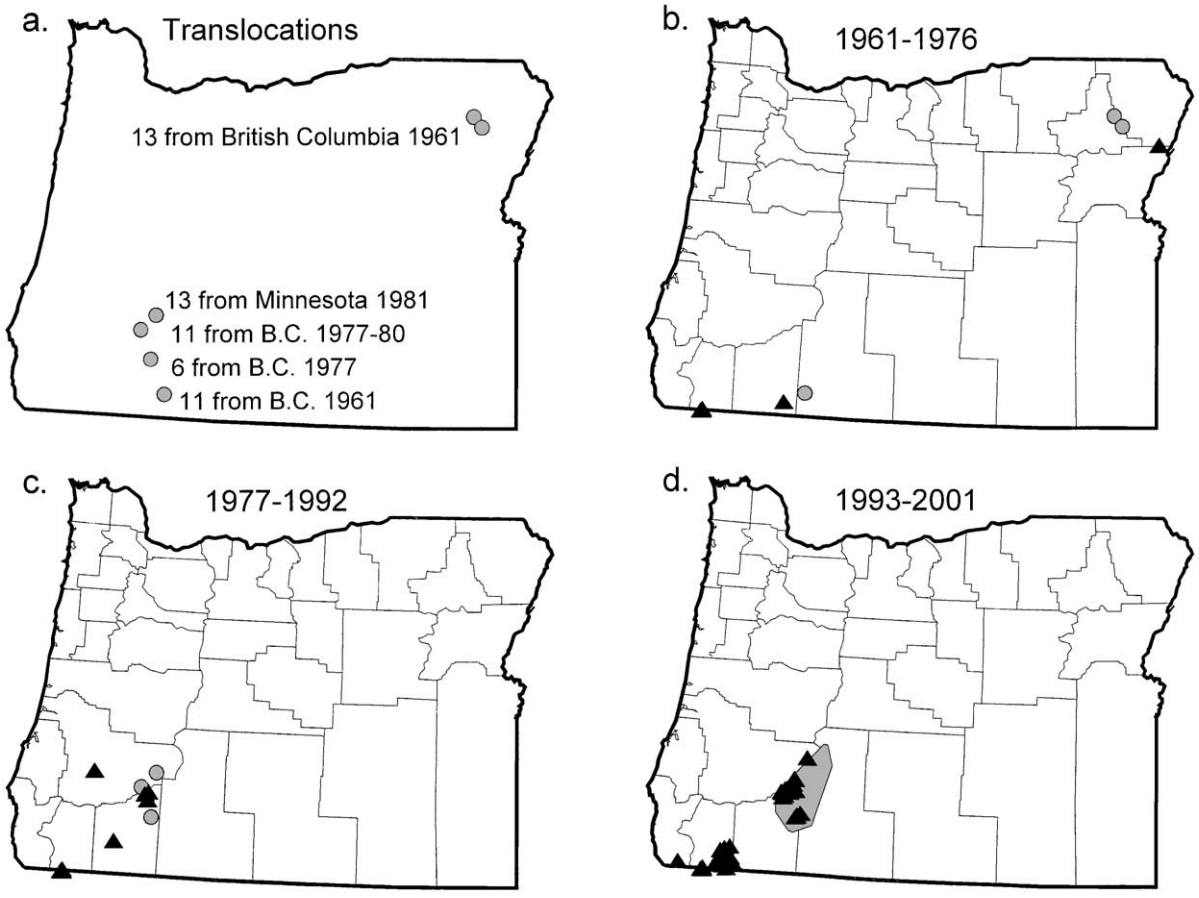


Fig. 1. Release sites (gray circles) for fishers translocated to Oregon between 1961 and 1981 (Fig. 1a) and the distribution of verified occurrence records (black triangles; reliability ratings 1 and 2) from 1961 to 2001 (Fig. 1b–d). Fig. 1b shows fisher records from the 15-year period after the 1961 translocations (1961–1976); Fig. 1c, records from the 15-year period after the 1977–1981 translocations were initiated (1977–1992); and Fig. 1d, recent records (1993–2001). The shaded area in Fig. 1d is the minimum convex polygon encompassing all point locations obtained during a 5-year radiotelemetry study of fishers in the southern Oregon Cascade Range (Aubry and Raley, 2002).

21 March 1961. To protect translocated animals, trapping or poisoning of any kind was prohibited for 5 years in a 625-km$^2$ area around the Klamath release area; presumably, a similar closure was established around the La Grande release area. We found no records regarding the fate of tagged animals from either release area, nor any indication that efforts were made to evaluate the effect that translocated fishers may have had on local porcupine populations.

Porcupines continued to cause extensive damage to forest plantations in southwestern Oregon (Dodge and Canutt, 1969), prompting seven timber companies and Douglas County to form the Fisher Introduction Cooperators in late 1974 to work with the Oregon State Wildlife Commission and the Umpqua National Forest to translocate fishers into the South Umpqua watershed in southwestern Oregon. From 1977 to 1980, a total of 11 fishers from south-central British Columbia were released about 30 km west of Crater Lake (Table 1, Fig. 1a). By 1980, ODFW could no longer obtain fishers from British Columbia for this reintroduction effort; consequently, they made arrangements with the Minnesota Department of Natural Resources to secure an additional 15–20 fishers from Minnesota for translocation to Oregon. Jim Schneeweis, the Area Wildlife Manager for the Minnesota Department of Natural Resources in International Falls, coordinated the project. In late 1981, 13 fishers were translocated from northern Minnesota to Oregon and released about 25 km northwest of Crater Lake, about 22 km northeast of the 1977–1980 release sites (Table 1, Fig. 1a).

There is no record that any of the 24 fishers translocated during this reintroduction program were tagged, nor that any attempt was made to monitor either the success of the reintroduction effort or its effect on local porcupine populations. However, two fisher specimens were collected near urban areas in southwestern Oregon during the time of the translocations. An adult female fisher was killed in a chicken coop about 8 km south of the city of Roseburg on 20 December 1979 (Douglas County Museum, Roseburg, OR; specimen no. XII.20.79.89), and an adult male was road-killed near the city of Medford in the spring of 1980 (Southern Oregon University Museum of Vertebrate Natural His-

tory, Ashland, OR; specimen no. 1705). Roseburg is about 75 km west and Medford is about 75 km south of the release sites. At the time they were collected, these were the first specimen records of fishers obtained in Oregon since 1913. The timing, location, and anomalous nature of these specimen records strongly suggests that they were translocated fishers that had dispersed into urban areas from their release sites.

To protect ponderosa pine (*Pinus ponderosa*) plantations that were being heavily damaged by porcupines, a biologist working for a private timber company in Medford, OR, arranged for six fishers to be translocated from south-central British Columbia to southwestern Oregon in the fall of 1977 (Table 1, Fig. 1a.). Two fishers were released at each of three locations spaced 10 km apart, 30–45 km southwest of Crater Lake. No information is available on the ages of translocated fishers and none were tagged.

### 2.3. Distribution of extant fisher populations in Oregon

We obtained 244 records of fisher occurrence in Oregon dating from 1954 to 2001: 33 reliability 1, 17 reliability 2, 69 reliability 3, 71 reliability 4, 27 reliability 5, and 27 reliability 6. Records of reliability 1 and 2 (verified records) for the 15-year period after the initial translocations in 1961 (1961–1976), were limited to one record in 1967 from Wallowa Co. in northeastern Oregon and 4 records in the 1970s from Josephine and Jackson Cos. in southwestern Oregon (Fig. 1b). Verified records for the 15-year period after the second series of translocations began (1977–1992) included 8 records dating from 1979 to 1992, all of which were from southwestern Oregon (Fig. 1c). We obtained 36 recent (1993–2001) verified records, all of which were from southwestern Oregon (Fig. 1d).

The spatial extent of unscreened fisher occurrence records in Oregon from 1954 to 1992, and similar records dating from 1955 to 1992 in Washington and 1960 to 1987 in California, suggests that the geographic distribution of fishers in the Pacific states is both widespread and continuous (Fig. 2a). Between 1989 and 2000, state and federal agencies throughout the Pacific states conducted standardized surveys for forest carnivores using remotely operated cameras and sooted track-plate boxes (Fig. 2b). This large-scale survey effort was conducted in most localities where fishers had been reported to occur based on unscreened occurrence records (Fig. 2a). The distribution of photo and track-plate detections of fishers resulting from these survey efforts (Fig. 2c) reveals a geographic distribution for fishers that contrasts strongly with that indicated by unscreened occurrence records.

Despite extensive standardized surveys conducted throughout forested habitats in Washington over the last decade, no photos or track-plate detections of fishers were obtained (Fig. 2c). The lack of detections from those surveys was an important factor in the subsequent listing of the fisher as an endangered species in Washington state in 1998 (Lewis and Stinson, 1998), and indicates that fishers may be extirpated in Washington. In Oregon, fishers were only detected in the northern Siskiyou Mountains near the California border in the southwestern corner of the state and in the southern portion of the Cascade Range in the vicinity of release sites for translocations that occurred from 1977 to 1981 (Figs. 1a and 2c). The latter area contains a resident population of fishers that the senior author (KBA) studied with radiotelemetry from 1995 to 2001 (Fig. 1d; Aubry and Raley, 2002). Fishers appear to have been extirpated from all other portions of their presumed historical range in Oregon (Fig. 2c). In California, fishers were detected only in the Klamath-Siskiyou region in northwestern California and in the southernmost portion of the Sierra Nevada; fishers appear to have been extirpated in the northern and central Sierra Nevada (Zielinski et al., 1995). Thus, the current distribution of fishers in the Pacific states is neither extensive nor continuous; due to extirpations throughout much of their former range, fishers are now restricted to several small and disjunct remnant or reintroduced populations.

## 3. Discussion

### 3.1. Extirpation of fisher populations in the Pacific Northwest

Because of their low densities and reproductive rates, fisher populations are particularly susceptible to overtrapping; even small increases in mortality rates above natural levels may lead to local extirpations (Powell, 1979a, 1993). Powell (1979a) predicted that fisher populations at equilibrium densities in the Upper Peninsula of Michigan would decline to extinction if they were subjected to annual human-caused mortality rates of $<1$ to about 4 fishers per 100 km$^2$, depending on the structure of the predator–prey community model used. If these predictions are even marginally applicable to fisher–prey community dynamics in the Pacific Northwest, the annual human-caused mortality rates indicated by trapping records from coastal Washington in the early 1920s (74 and 10 fishers per 100 km$^2$) would have had devastating effects on the sustainability of local fisher populations.

Although these reports alone reflect intense trapping pressure, they only represent the harvest of fishers in two relatively small areas by four individuals. Given the value of fisher pelts at that time, their vulnerability to trapping, and the accessibility of their primary habitat, it is likely that other trappers were also harvesting

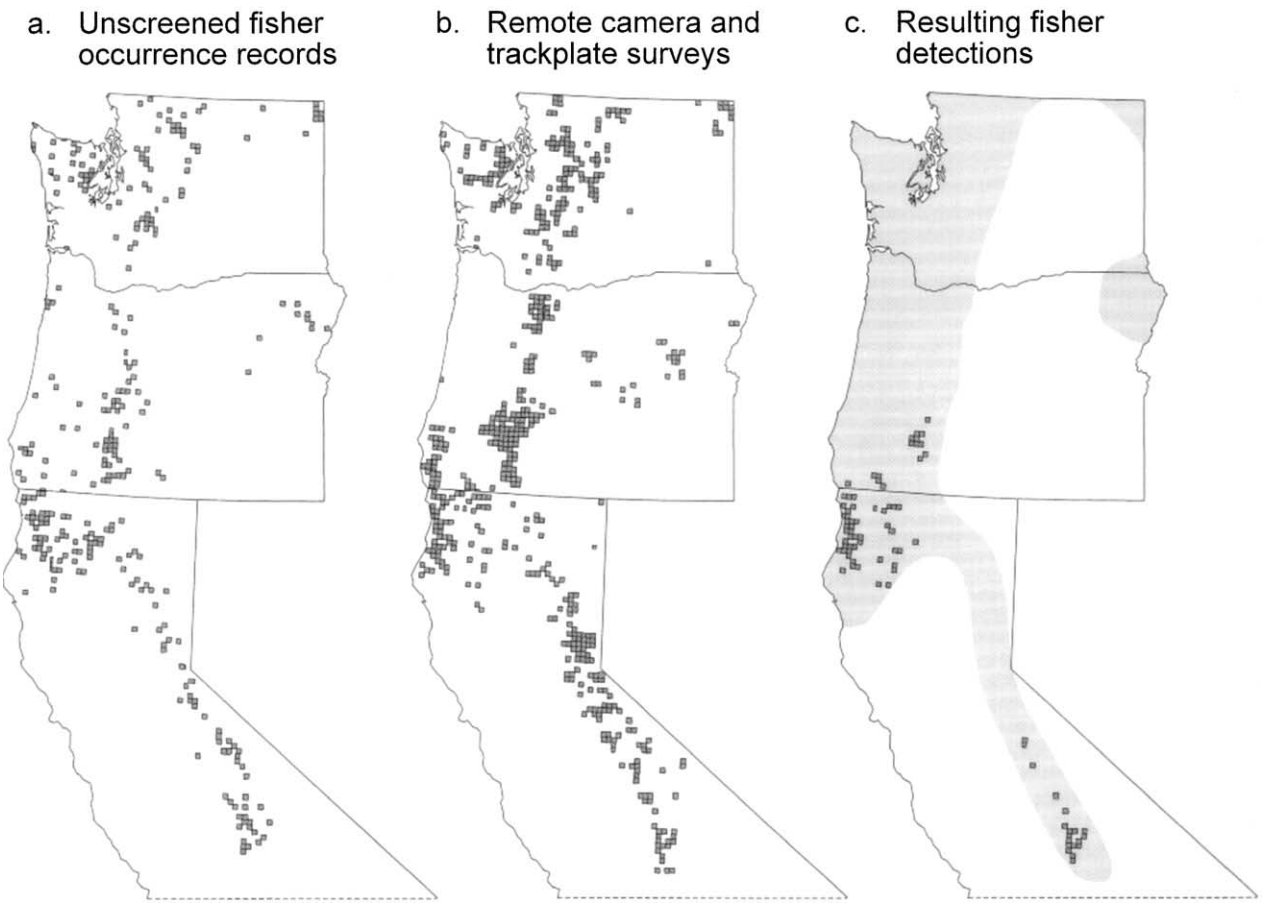


Fig. 2. Unscreened fisher occurrence records (reliability ratings 1–4; Fig. 2a) and the location (Fig. 2b) and results (Fig. 2c) of standardized surveys using remote cameras or sooted track-plate boxes in the Pacific states. Fig. 2a is based on data from 1955 to 1992 in Washington (Aubry and Houston, 1992), 1954 to 1992 in Oregon (this study), and 1960 to 1987 in California (Schempf and White, 1977; Gould, 1987). Figs. 2b and 2c are based on data from 1990 to 1997 in Washington (Lewis and Stinson, 1998), 1990 to 2000 in Oregon (this study), and 1989 to 1994 in California (Zielinski et al., 1995). The minimum mapping unit shown in all figures is 1 township (36 miles$^2$ [93.2 km$^2$]); townships were plotted whenever one or more occurrence record, survey effort, or photo/track-plate detection was made within that township. The shaded area in Fig. 2c represents the presumed historical distribution of fishers in the Pacific states (modified from Hagmeier, 1956 and Gibilisco, 1994).

fishers from coastal Washington, and that similar trapping pressure was being exerted on fishers throughout their range in the Pacific Northwest. In 1933, when Washington state established the Department of Game and began regulating commercial trapping seasons and harvest levels, fishers had already become so rare in the state that they were given complete protection from trapping. Similar declines in fisher harvests in Oregon and California, and resulting concerns about the potential extinction of fishers from overtrapping (Jewett, 1915; Dixon, 1925; Lewis and Zielinski, 1996) eventually led to the protection of fishers in Oregon and California in 1937 and 1946, respectively.

Decades of protection from trapping and poisoning, however, have not resulted in the recovery of fisher populations in the Pacific states. Throughout their historical range in Washington and Oregon, fishers have either been extirpated or persist only in small, isolated areas (Lewis and Stinson, 1998; this study). In California, the fisher's range has also diminished substantially; fishers occur only in the Klamath-Siskiyou region of northwestern California, and in the southern Sierra Nevada (Zielinski et al., 1995).

### 3.2. Distribution and status of extant fisher populations in Oregon

The geographic distribution of fishers in Oregon has been greatly reduced in extent from pre-settlement conditions (Fig. 2c); currently, documented records of fishers are restricted to two small, disjunct areas in southwestern Oregon (Fig. 1d). Each cluster of records is located in a different physiographic region: the northeastern cluster is in the southern Cascade Range, whereas the southwestern cluster is in the northern Siskiyou Mountains. The lack of high-reliability occurrence records, and the low suitability of habitat conditions in the area separating these two montane regions, suggest that this apparent discontinuity in the distribution of fishers in Oregon is real. The intervening

area contains a 4-lane interstate highway (Interstate 5), urban and agricultural development in and around the city of Medford, and extensive areas of open grassland and oak savannah in the interior Rogue River valley (Franklin and Dyrness, 1973).

Microsatellite DNA evidence indicates that these two clusters of records represent distinct populations that are genetically isolated from each other (Aubry et al., 2003b). Ancillary to an ecological study of fishers in the southern Cascade Range in Oregon (Aubry and Raley, 2002), KBA collected tissue samples from 18 fishers from that population, and obtained two additional samples from animals trapped incidentally in the northern Siskiyou Mountains. During the course of that study, a large proportion of the population of fishers occurring in the southern Cascade Range was sampled (Fig. 1d); thus, it is likely that Aubry et al. (2003b) detected all of the alleles that were present in that population for the loci sampled. Consequently, the occurrence of alleles at two loci in fishers from the northern Siskiyou Mountains in a homozygous condition (152/152 and 224/224) that were not detected in fishers from the southern Cascade Range (Table 2), provides strong evidence that the two fishers from the northern Siskiyou Mountains belong to a population that is genetically isolated from fishers in the southern Cascade Range.

In addition, variation in mitochondrial DNA (mtDNA) gene sequences (haplotypes) shows that the population of fishers in the southern Cascade Range in Oregon is a reintroduced population that is descended from fishers translocated to Oregon from British Columbia and Minnesota (Drew et al., 2003). Eight distinct mtDNA haplotypes were found in fishers from northern Minnesota, south-central British Columbia the southern Oregon Cascade Range, and northwestern California (Table 3). If fishers in the southern Oregon Cascade Range are indigenous, they would be expected to share haplotypes with fishers occurring in northwestern California. However, fishers in the southern Oregon Cascade Range contained two haplotypes (9 and 10) that were otherwise found only in fishers from the source populations of reported translocations (south-central British Columbia and northern Minnesota); neither haplotype occurred among fishers from northwestern California.

Table 2
Occurrence of alleles at selected loci in fishers from the southern Cascade Range and northern Siskiyou Mountains of Oregon (modified from Aubry et al. 2003b)

| Geographic location | Microsatellite loci | | | | |
|---|---|---|---|---|---|
| | Mvi 39[a] | | Mvis 002[b] | | |
| Southern Cascade Range | 142/144 | 144/144 | 220/220 | 220/228 | 228/228 |
| Northern Siskiyou Mountains | 152/152 | | 224/224 | | |

[a] Primer developed by O'Connell et al., 1996; $n = 17$ for the southern Cascade Range, $n = 2$ for the northern Siskiyou Mountains.
[b] Primer developed by Fleming et al., 1999; $n = 18$ for the southern Cascade Range, $n = 2$ for the northern Siskiyou Mountains.

Table 3
Occurrence of mitochondrial DNA haplotypes among fishers from northern Minnesota ($n = 18$), south-central British Columbia ($n = 31$), the southern Cascade Range in Oregon ($n = 9$), and the Klamath-Siskiyou region in northwestern California ($n = 18$)[a]

| | Northern Minnesota | South-central British Columbia | Southern Cascade Range, Oregon | Klamath-Siskiyou region, California |
|---|---|---|---|---|
| Haplotypes present | 10, 11 | 1, 4, 6, 7, 9 | 9, 10 | 1, 2 |

[a] Haplotypes 3, 5, and 8 did not occur in samples from these populations (modified from Drew et al., 2003).

Morphometric data provide additional evidence that fishers in the southern Cascade Range in Oregon are descended from translocated animals. Fishers from south-central British Columbia and northern Minnesota are significantly larger (based on condylobasal length) than fishers from the Pacific states, which are among the smallest fishers in North America (Hagmeier, 1959). Adult male fishers captured in the southern Oregon Cascade Range from 1995 to 2000 had a mean body weight of 5.91 kg ($n = 7$, S.D. = 0.60); adult females averaged 2.80 kg ($n = 9$, S.D. = 0.29; K. Aubry, unpublished data). In contrast, adult male fishers from the Klamath-Siskiyou region in northwestern California captured from 1993 to 1996 had a mean body weight of 3.82 kg ($n = 10$, S.D. = 0.37) and adult females averaged 2.08 kg ($n = 16$, S.D. = 0.22; W. Zielinski, unpublished data). Both male and female fishers from the southern Cascade Range in Oregon were significantly heavier than those from the Klamath-Siskiyou region in northwestern California (M: $t = 8.96$, d.f. = 15, $P < 0.001$; $F$: $t = 7.22$, d.f. = 23, $P < 0.001$). Although differences in mean body weight among adult males could reflect regional variation in the nutritional value of available food, such differences are not predicted to occur among adult females (Powell, 1979b). Thus, differences in mean body weight between these two populations cannot be explained solely on the basis of food supply.

Based on the history of fisher translocations to Oregon (Table 1), changes in the geographic distribution of fishers in both space and time (Fig. 1), and genetic (Tables 2 and 3) and morphometric differences among extant populations, we conclude that the population of fishers occurring in the southern Cascade Range in Oregon is descended from fishers that were translocated to that area from south-central British Columbia and northern Minnesota between 1977 and 1981. Although it appears that fishers in the northern Siskiyou Mountains

in Oregon may represent the northern extent of indigenous populations of fishers in northwestern California (Fig. 2c), additional research on the genetic relationships of fishers in that region is needed to evaluate this hypothesis.

### 3.3. Implications for fisher conservation and management in the Pacific states

The results of standardized surveys conducted with remote cameras and sooted track-plate boxes during the 1990s in Washington, Oregon, and California (Zielinski et al., 1995; Lewis and Stinson, 1998; this study) show that the geographic distribution of extant populations of fishers in the Pacific states is limited to several relatively small and disjunct populations. These include a reintroduced population in the southern Cascade Range in Oregon, and indigenous populations in the Klamath-Siskiyou region of northwestern California and extreme southwestern Oregon, and in the southern Sierra Nevada (Fig. 2c). Extant populations of fishers in California are separated by a distance of 420 km (Zielinski et al., 1995) and fishers in the southern Cascade Range in Oregon are ~75 km from those occurring in the northern Siskiyou Mountains (Fig. 1d). The distance between the population of fishers in the southern Oregon Cascade Range and the nearest extant populations in southern British Columbia is >650 km (M. Badry, personal communication).

Data on juvenile dispersal in fishers are limited, but work in Maine (Arthur et al., 1993), Massachusetts (York, 1996), Idaho (Jones, 1991), and Oregon (Aubry et al., 2003b) indicate that maximum dispersal distances are <100 km in suitable habitat. The extent to which fishers are capable of dispersing across unsuitable habitat has not been studied, but is believed to be limited (Powell and Zielinski, 1994). Consequently, potential barriers to dispersal (e.g. large rivers or interstate highways) and a lack of suitable habitat in intervening areas (e.g. non-forested areas or rural and agricultural development), further diminish the likelihood of successful dispersal, gene flow, and demographic support among extant populations of fishers in the Pacific states.

A 1994 petition to list Pacific coast and northern Rocky Mountain fisher populations as threatened under the Endangered Species Act (Carlton, 1994) was rejected because the evidence presented failed to demonstrate that fishers in the Pacific and northern Rocky Mountain states constituted distinct population segments (DPS) listable under the Act because "the continuity of the fisher's range through Canada, and between Canada and the United States, provides for genetic interchange throughout North America" (US Fish and Wildlife Service, 1996). These conclusions were based largely on the geographic distribution of recent unscreened occurrence records (Fig. 2a). Our results demonstrate that such data do not provide a reliable basis for conservation decision-making, and that the geographic continuity that once provided for genetic interchange among fisher populations in western North America no longer exists.

Fishers have been protected from trapping and predator-control efforts in the Pacific states for >50 years, and recent bans on the use of body-gripping traps in California and Washington will reduce or eliminate the death or injury of fishers in traps set for other furbearers. In addition, the ecosystem management objectives embodied in the Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management, 1994) are expected to contribute substantially to the restoration and protection of suitable habitat for fishers on federal lands within the range of the northern spotted owl (*Strix occidentalis caurina*). However, the inability of extant fisher populations to support one another demographically, including those that are isolated by relatively small distances (Fig. 1d), or to colonize currently unoccupied areas within their historical range, are significant conservation concerns.

The geographic extent of fisher population losses in the Pacific states will limit the degree to which additional conservation measures can provide for the recovery of their populations. Because the distribution of fishers in western Canada has remained relatively stable (Gibilisco, 1994), restoring connectivity between fisher populations in southern British Columbia and the Pacific states is likely to be a key component of conservation strategies for the fisher in the western USA. Continued survey and monitoring efforts in the Pacific states will be needed to determine if extant fisher populations are expanding their range naturally and reoccupying extirpated areas. In the absence of such range expansion, however, it may be appropriate to consider additional reintroductions of fishers to the Pacific states. Although fishers have been reestablished in the southern Cascade Range in Oregon for >20 years, our results show that they have not expanded their range beyond a relatively small area (Figs. 1b–d), suggesting that suitable habitat in surrounding areas may be inadequate to support fishers. Because the current suitability of habitat conditions for fishers in Washington and unoccupied areas of Oregon and California is unknown, comprehensive feasibility studies should be conducted prior to additional fisher reintroductions (e.g. Lewis, 2002). Such studies include explicit considerations of objectives, habitat capabilities at multiple spatial scales, genetic suitability of potential source populations, timing of releases, possible social or economic constraints, mechanics of the reintroduction, and the optimal age, sex, and number of translocated animals, among others (Berg, 1982; Griffith et al., 1989; IUCN, 1995).

Lastly, important opportunities for gaining knowledge from previous fisher reintroduction efforts in Oregon were lost because no attempt was made to document the

fate of translocated fishers, nor to study the effects of fisher translocations on ecosystem structure or function (Aubry et al., 2003a). We urge those involved in future reintroduction efforts for fishers to include substantive monitoring and research components in their program planning.

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